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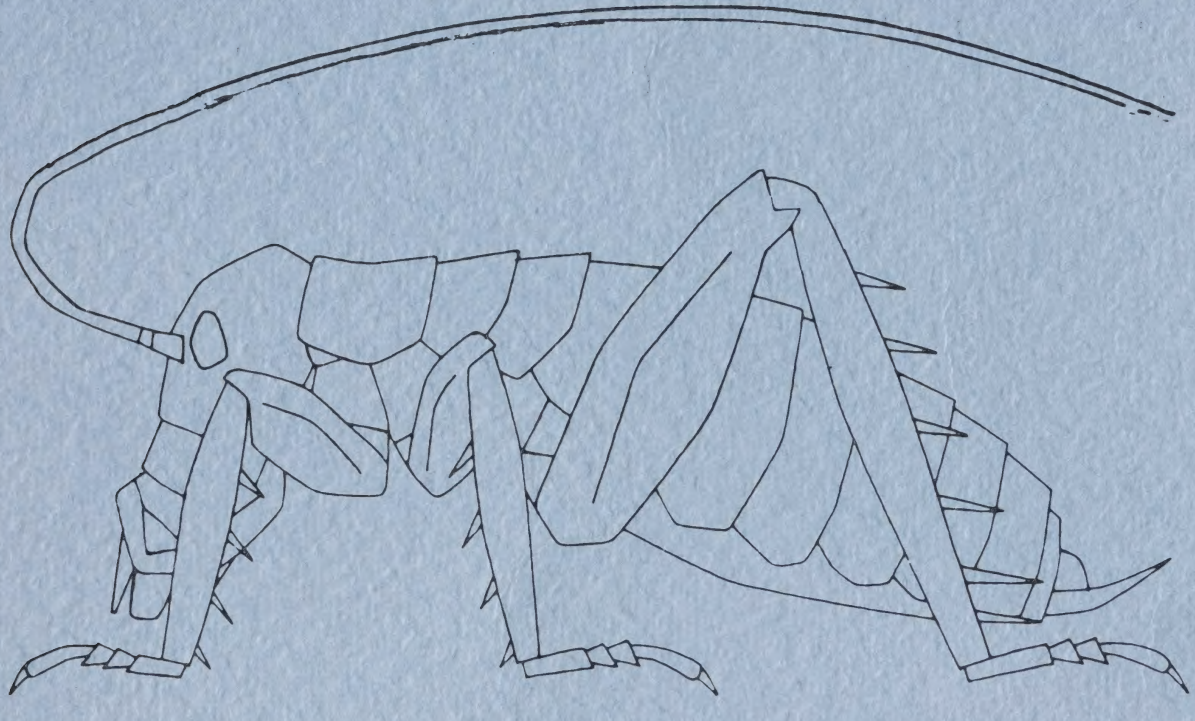

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The following project won "Best in Fair" and 1st in the Intermediate Biological Sciences section at the 1989 Wellington Science Fair. The girl who undertook the project is only 14 and did all the work, including typing the results into a computer, herself.

*

A STUDY OF SPIDERS

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ABSTRACT

I have studied spiders of the species *Eriophora pustulosa* (Walckensaer, 1841) and their web-building. The project consisted of two sections. In the first the spiders were put into unusual conditions, and they were observed to see if they would build a web. The condition were: light intensity, movement, space around them and the condition of the spiders' legs. They built at between three and five electron Volts of light, which is the light intensity of early evening. They would build if they were rotated on a horizontal plane but not if they were rotated on a vertical plane. Small spiders build in smaller areas than larger spiders, although larger spiders can build in small areas if they get hungry enough. Spiders which are regenerating their forelegs built webs with slightly tighter coils and more radii than normal spiders of that size. If they were missing any other legs they built normally.

In the second section the spiders were put onto each other's webs. *Eriophora pustulosa* will take over each other's webs, those of *Colaranea viriditas* (Urquhart, 1886) and those of other species of the Araneidae if the owner is not there. However they will not take over the webs of *Achaearanea veruculata* (Urquhart, 1885). If the owner is there, the larger spider will take over the web. If they are moved when they have prey, they have a slight recollection that they have it, but it is soon forgotten. If they are moved while they are in the middle of building the web they will continue from where the web was interrupted.

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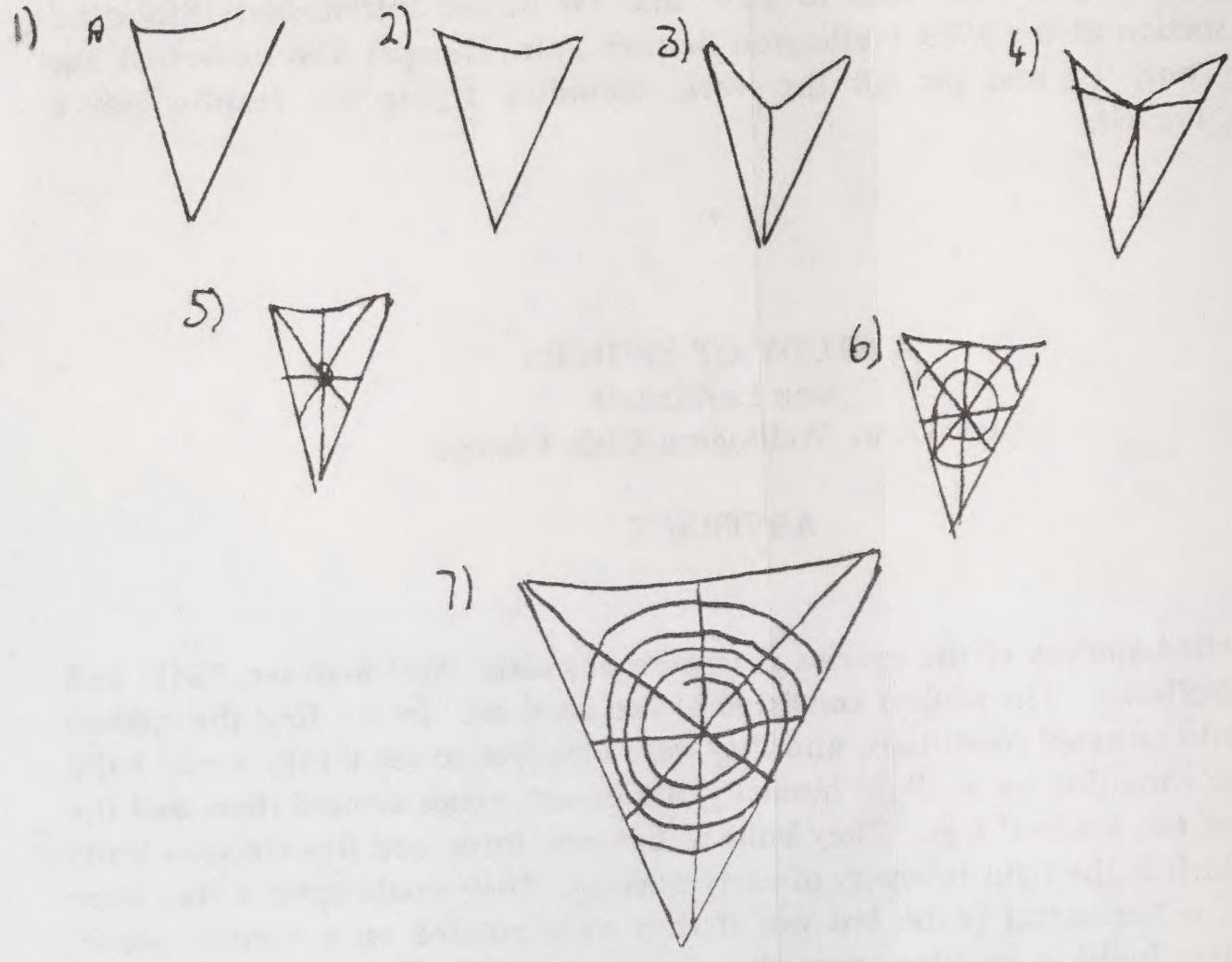


Parts of a Spider

Building an orb-web

1) Ballooning. The spider stands at (A) and lets a piece of silk go.

2) When the silk lands and sticks, the spider replaces it with a thicker thread.

3) Another piece is dropped from the centre, forming the basic frame of the web.

4) The 1st group of radii are built on one side of those already built.

5) The rest of the radii are built.

6) The auxilliary spiral is built out of fine silk.

7) The catching (sticky) spiral is built, and the spider takes up the auxilliary spiral.

INTRODUCTION

The spider is a misunderstood animal. Many people scream at the sight of one, and others squash them. In fact, this fear is unjustified. Most spiders are harmless to man, although they can bite. The only one which cannot is the daddy long legs (Pholcidae: *Pholcus phalangioides*). In New Zealand, only a few of the two thousand or more species of spiders found are harmful to man. They are the notorious Katipo (*Latrodectus katipo*) and its relatives in the family Theridiidae, including a common cobweb spider.

Another misconception about spiders is that they all build orbwebs. The orbweb is, in fact, only built by a single family of spiders - the Araneidae. Some other types of spiders, such as hunting and trapdoor spiders, do not build webs at all. Others (tunnelwebs) have a combination of tunnels and webs. Species of other families build different types of webs. These range from the dense mass of strings built by the sheetweb spiders to the single string of the bolas spiders.

But even spiders with similar types of web are not necessarily related. There are two types of spiders, which appear to have evolved their web building techniques separately. They are called the cribellate and the non-cribellate spiders. The difference between them is the type of silk they weave. The cribellate spiders have an extra spinneret, known as the cribellum, which the non-cribellate spiders do not have.

This study has focused on a single species of the Araneidae, which is a family of non-cribellate spiders. The species is *Eriophora pustulosa* (Walckenaer, 1841), the common garden orbweb spider. This spider was known until 1987 as "*Araneus pustulosus*". One species of cobweb spiders (family: Theridiidae) was also used: *Achaearanea veruculata* (Urquhart, 1885), a native species.

The webs even within a single family can vary a lot. For example, *E. pustulosa's* webs are similar to those built by *Colaranea viriditas* (Urquhart, 1886), known until 1987 as "*Araneus viriditas*", but the catching spiral is not as tight. Therefore, it is often possible to identify each spider by its web.

It is even easier to tell the difference between the webs of the Araneidae and the Theridiidae. The Araneidae build the typical orbweb, which is the spiral web people think of when they think of a spider's web. The cobweb is the loose, stringy web which you find hanging in corners, and does not look in the least like the orb-web.

This study was divided into two sections. The first investigated the conditions under which spiders would build normal webs. The factors tested were light intensity, movement, space around them and the condition of the spider's legs. The second section was about the spiders' reactions to being moved onto unfamiliar webs. The webs tested were those of *E. pustulosa*, *C. viriditas* and *A. veruculata*.

The results of these experiments and observations give us some insight into the life of one of the most fascinating small animals, the spider.

SECTION ONE

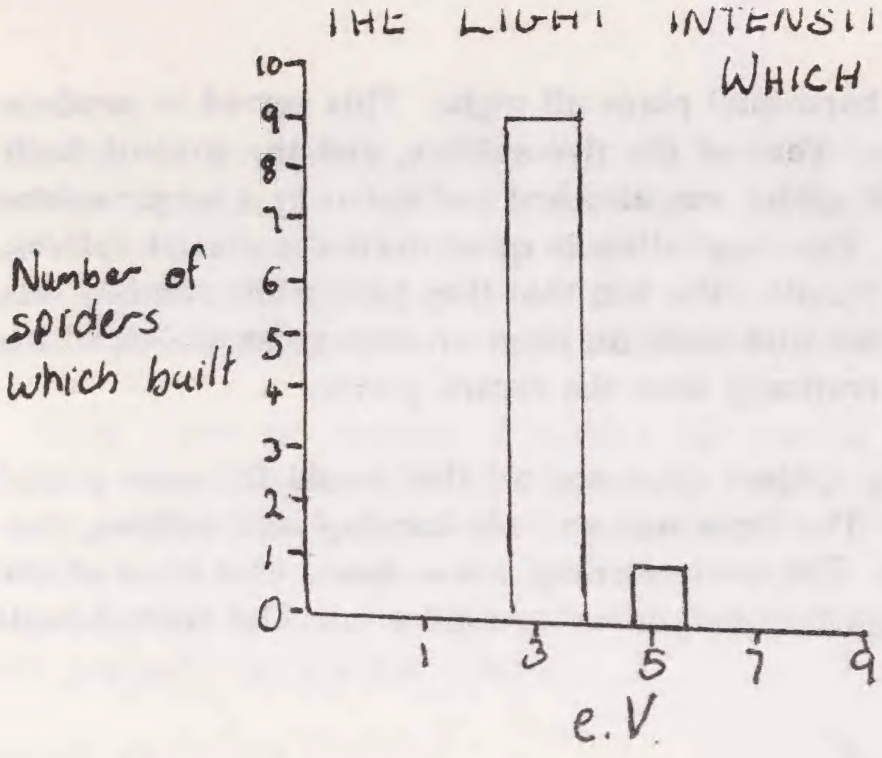
LIGHT INTENSITY:

The first set of experiments tested the light intensity in which spiders would build webs. The first experiment tested the spiders' ability to build in complete darkness.

Five spiders were placed on twigs in an area without any light. A sixth spider was left outside in the normal light intensity of early evening, but otherwise in the same conditions. The next day, the results were recorded, and the spiders movements were traced by the silk which they trail behind them at all times. The control had built a normal orb-web, but four of the others did not move at all. The fifth spider climbed up to the top of her stick, and did nothing else. This was a surprising result, as they are nocturnal animals. Perhaps they have so many eyes because they need to be able to see in dim conditions. *E. pustulosa* has eight eyes.

The second experiment was to test whether they would build a web in bright light. This experiment was set up as for the previous one, with five spiders inside a box, and one outside as a control. A light was put inside the box with the spiders, and was left on. The next morning the results were recorded as before. None of the spiders tested built a web, although the control did. The only movements of the spiders were to get as far away from the light as possible - onto the other side of the twig.

At this point they did not seem to be building at all. Therefore, the next step was to find out at what light intensity they would build a web. A light was placed at one end of a dark room, and the spiders were placed at various distances away from it. This meant that three spiders were placed where the light was nine eV (electron Volts) as measured on the photographic light meter, three spiders were where the light was seven eV, three at five eV, etc. This was repeated until ten spiders of varying sizes had been tested at each point.



Most spiders built at about three eV. This was found to be the same light intensity as at dusk and dawn. So it appears that spiders only build at these times in the wild, not at all night as I had thought.

I then wondered whether they could build if the light changed from three eV to nine eV. This was tested in the same manner as the first two experiments, with the light inside the box with the spiders. It was changed at irregular intervals, and the results were recorded. All the spiders built normal webs, but none of them made any attempt to build during the time the light was on.

Therefore it seems that spiders will not build in bright light, or complete darkness. Instead they prefer to do it in dim light - around three eV.

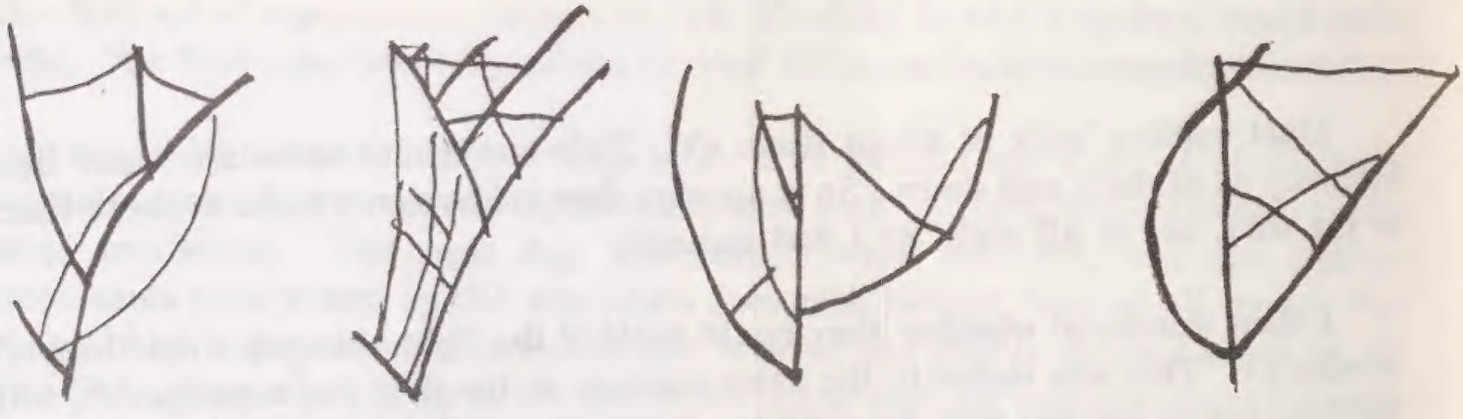
MOVEMENT:

The second set of experiments tested whether spiders could build if they were moved regularly. The idea of this section came after reading an experiment in "Biology of Spiders", by Rainer F. Foelix. He mentioned some orbweb spiders (*Araneus diadematas*, a British relative of *E. pustulosa*) which had built normal orb-webs in space, without any gravity at all, inside a space shuttle.

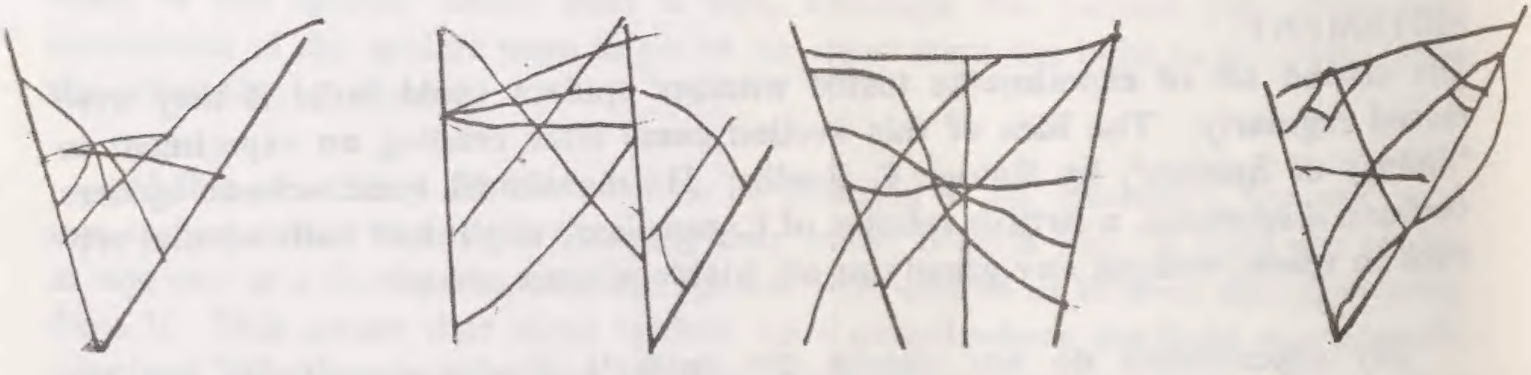
My experiments do not change the spider's gravity completely, but the movement may affect the spider. In the first experiment the spiders were placed (on suitable twigs) on the turntable of a record player, which rotated (at thirty

three rounds per minute) on a horizontal plane all night. This served to produce centrifugal force on the spiders. Four of the five spiders, and the control, built perfectly normal webs. The fifth spider was attacked and eaten by a larger spider which came across to its stick. This canibalism is quite normal amongst spiders, even when a male is courting a female. The fact that they built while rotating was not too surprising. Spiders in the wild build on twigs or even grass stalks, which move in the wind much more erratically than the record player.

In the next experiment four spiders (that was all that would fit) were placed on twigs inside a clothes dryer. The dryer was on "cold-turning" and nothing else. The dryer was left on all night. The next morning it was found that none of the spiders had built a web, although they had moved around a lot. The control built normally.



After this, I wondered if it was just the continual vertical rotation that bothered them. The next experiment tested this hypothesis. The spiders were placed on twigs suspended vertically from a piece of wool. Every half hour throughout the night the twigs, with the spiders on them, were turned one hundred and eighty degrees. None of the spiders built normal webs - although most of their structures had parts that look like pieces of webs.



None of the spiders built either the auxilliary or catching spirals, although most had begun the radii at some stage. Just before the first time they were rotated they all appeared to be building perfectly normal webs. Straight after turning each time they just stood still on either the twig or the centre of their construction for five to ten minutes, before resuming work.

This made me wonder if sudden movements were preventing them from building normal webs. The spiders on the record player, where the movement had been smooth and continuous, had built normally. Therefore, the next experiment tested whether they would build when bumped at regular intervals. They were suspended on strings overnight, and they were bumped every half hour. They all built normally (as did the control).

SPACE AROUND THEM:

While doing the first sets of experiments it was observed that spiders did not build webs in two litre ice-cream containers. The reason was unclear, as they built normally in the empty aquarium (300 mm x 500 x 250 mm) they were sometimes left in. Therefore some experiments were devised to find out why ice-cream containers were not suitable.

One of the things varying between the ice-cream containers and the aquarium, was how the light got in. That is, in ice-cream containers the light enters only from one angle, when in an aquarium the light enters from all sides. Therefore the experiment tested whether spiders could build a web in a box of a similar size to an ice-cream container, if it was clear on all sides. The spiders were put into a clear container on a twig and left overnight outside in the garden. Still none built, while the controls built normal orbs. Perhaps it was because there was no stimuli for them to build? Maybe they could sense that there were no insects around. In the next experiment the spiders were put back into the ice-cream containers, and a couple of live insects were added. They still did not build. Instead they spent the night hunting the insects like hunting spiders.

I looked back over my observations of how spiders build their webs. The first movement is to get a single thread from point (a) to point (b) (see figure 1). This thread forms the basic bridge which holds the whole web together. They spread the thread between branches by letting a light piece of silk go, with a drop of glue on the end. If the thread hits another object, it will stick and form the bridge. If it does not, the spider will reel it back in and try again. The thread is moved about by the wind. That could have been one reason why they would not build in a confined space: there was no wind. In the aquarium there was a very slight air flow, as there were open corners, and it was much larger.

A few months later the spiders were left in ice-cream containers overnight, while the next experiments were set up. Four out of five spiders built. This was a surprising result, as previous experiments seemed to prove that ice-cream containers were unsuitable. They were left in again the next night, and all five built normal webs. No conditions appeared to have changed from the original experiment. None, except for one thing - that the spiders had already been in captivity for ten days. This was unusual as until then they had always been released after three days, because of my difficulties in feeding them. These spiders were released, and others replaced them. This time, under identical conditions, none built. It seems that some spiders can build in ice-cream containers. Perhaps it can be explained like this: It is possible for them to build in the ice-cream containers, but it is more difficult without air-flow. Therefore the spiders will not build for the first few days, but try to escape instead (this is supported by the fact that they are always at the top of the containers where the light comes in, and the fact that they are always very eager to get out when the containers are opened). When they get hungry, which can take several days as a single house fly can feed a spider for over a week, the spider would build, in spite of abnormal conditions. After this experiment no spider were kept longer than three days, as they seemed to be more willing to build after the fourth day.

However, a week later, a spider built a web in an ice-cream container about three hours after it had been captured and placed inside. The conditions were the same as before but something was different. Perhaps the spider had not caught any prey before if was captured? It seem unlikely, as on average most spiders catch at least five small insects a day, according to a count I made during the study. The only difference was the size of the spider. This particular spider was much smaller than any of the others. It was about five millimetres across, when most of the others had been about one centimetre across.

To find out if this was an unusual result, five spiders of a similar size were tested that night. They all built normal webs. Therefore, did the large spiders not build because they did not have enough space? It seems unlikely, because they can build when they get hungry.

It seemed to lead back to the question of airflow, as smaller spiders use lighter silk. The silk's weight seems to vary with the size of the spider. I had observed that smaller spiders' silk blows much further than the larger spiders. This seemed to be related to the size of the drops of glue. These drops are emitted from the spinnerets which increase in size as the spider grows. Larger spiders emit larger drops (and therefore heavier silk) than smaller spiders. This can be seen by

looking at spiders' silk under a high powered microscope. So, in the confines of an ice-cream container, the lighter silk produced by smaller spiders might be able to move, while that produced by larger spiders would not.

This hypothesis was tested by allowing a group of larger spiders to build their first strand on a forked twig before they were put into ice-cream containers covered with transparent wrap, overnight. Still none of the five built. I thought that perhaps they can sense when they are enclosed in a relatively small place. This is not an unreasonable idea, as they seem to be able to sense when someone comes near them on a web in the wild. They show us this by vibrating the web rapidly.

I tested this by putting spiders into four sizes of container. All the spiders were the same size and had been captured at the same time. One was put into a one litre ice-cream container, one into a two litre container, one into a container formed when two litre ice-cream containers were put together, and the last in a container formed when four two litre containers were put together. They were left overnight on twigs. It was repeated on three consecutive nights with different spiders. Each night the results were the same. The spiders would build in none but the largest container. This seems to prove that they can sense when they are in a confined space, and therefore will not build.

REGENERATED LEGS:

One of the spiders used had uneven legs: its left foreleg was shorter than its right foreleg. She was observed over the following weeks, until after several moults the leg grew back.

In the building of orbwebs the legs seem to be fairly important. Therefore spiders missing forelegs (due to natural causes) were monitored to see if they would build normal webs. They were left in their natural conditions, where their webs were observed in the morning, and compared with those built by normal spiders of the same size. They all built similar orb-webs. One difference was that the coils of the catching spiral were much closer together in the webs of the spiders that were regenerating legs than in webs of normal spiders. There were also more radii in the former webs. It was found that as spiders build their webs they measure the angles between the radii with their front legs. When one front leg is missing or is shorter the angles are smaller - therefore more radii are needed. The same principle affects the catching spiral. As they lay the coils of the auxiliary spiral (which serves as the guide while they build the catching spiral), they measure the distances with their front legs. Therefore, with a shorter leg the spirals are much closer.

During my observations I noticed that none of the other legs seemed to be used, so some experiments were done using the same method to find out their function in web building. They all built perfectly normal webs. Therefore the other legs must be for other functions than web building.

Vollrath (1987) described experiments similar to mine using *Araneus diadematas* spiders. His results were similar to mine.

SECTION TWO

In the second half of this project the spiders were moved onto each others' webs and their behaviour was observed. *E. pustulosa* spiders were put onto webs of: *E. pustulosa, C. viriditas* and *A. veruculata*. Before I did the experiments I observed the spiders for two months, so I could recognise normal and unusual behaviour. Much of the behaviour observed during this time is irrelevant to this project, but details of the observations are listed in my log-book.

In the first experiment two *E. pustulosa* spiders were put onto each others' webs. This experiment and all those following were repeated at least three times (i.e., a minimum of six spiders were tested).

The spiders were all placed onto different parts of the web, but their reactions were basically the same. They all paused cautiously for between thirty seconds and a minute, while they tested the strings of the web to see how taut they were. After finding that the strings were all equally loose, they sensed that there was no other spider on the web. Then they went straight along the nearest radius and settled in a hub, gathering the ends of the radial threads under them, as is the custom of this species of spider. They tested all the radii they had not been able to reach for signs of life. When they found that there were none they settled down and behaved normally for the rest of the day, eating any insects that were caught in the web. They rebuilt again in the normal manner at night, even to the point of eating the threads that were cut down (spider silk is mainly formed of protein). After that they continued to use the basic circular frame work of the web they were moved onto, although they rebuilt the radii and catching spiral.

This experiment was repeated with spiders of different sizes (and therefore ages), but still using the same species. When an adult spider was placed on the web of a young spider, the latter moved off immediately and fell to the ground, eventually building its own web elsewhere. When it was a young spider it either

moved off or stayed at the edge of the web, building a web of its own between the radii which are often extended below the web.

The next experiment tested webs which seemed identical at first glance, but they were built by another member of the same family, *C. viriditas*. The webs of *C. viriditas* are very similar to those of *E. pustulosa*, except the former are smaller and have tighter coils. I think this is because they are smaller spiders with shorter legs, and it seems that these factors alter the web (see experiments above). An *E. pustulosa* spider of the same size with stunted legs would build an identical web to that of *C. viriditas*. For each of the experiments I have mentioned using *C. viridatas* I have also tested other spiders of the same family. These other spiders are *Zealaranea crassa* (Walckenaer, 1842) and two unidentified members of the Araneidae. These four are the only members of this family in the area, except one. The other is very rare, and only one specimen was found. It is *Leucage dromedaria*. In all the experiments the results were the same whichever species of spider I used.

For this experiment the *E. pustulosa* spider was moved onto the web of *C. viriditas*. The results were identical to those in which *E. pustulosa* spiders were put onto other webs belonging to spiders of the same species. It is interesting to note that when the experiment was repeated with *C. viriditas* spiders being moved onto *E. pustulosa* webs, the results were still the same.

These experiments lead to an interesting question. Why do spiders not do this regularly? It would be advantageous to do so, as they do not have to waste their time and energy making their own webs. Nor do they have the investment of the silk, which uses a lot of energy to produce because of its high protein content. The spider could just eat insects caught in someone else's web, without its own effort which would be wasted if the web was blown down.

Therefore there must be a reason why this does not happen. The obvious one would be that the spider on the web would scare off the intruder. In the first three experiments the spiders were put onto unoccupied webs, which are rare in nature. The next experiments were done with the spiders still on the webs. The first one involved two *E. pustulosa* spiders. At first there seemed to be no logic in their behaviour - sometimes they left, sometimes they stayed and sometimes they advanced further onto the web. But after several repeats the reason became clear. If the spider that was introduced was the smaller of the two, it was quickly chased off by the owner of the web. The owner would charge aggressively, with her palps outstretched to show her fangs. This was enough to frighten the smaller spider, who would drop off the web immediately. This reaction was probably due to the fact that spiders are cannibalistic. But if the introduced spider was the larger one,

she would chase the owner of the web, and take it over. When the two spiders were of similar size their reactions were different. As soon as the new spider was introduced the resident would come out of her retreat, if she was in one. Both spiders would open their palps threateningly, but neither would advance or retreat. This would go on for some time, with neither spider gaining any territory. Eventually they would both give up and go and build a new web elsewhere. On some occasions the resident spider would return to her retreat, and take possession of the web after the other had built one of her own (if it was evening), or settle down elsewhere. The same results were observed when the experiment involved an *E. pustulosa* spider and a *C. viriditas* spider. This shows us that the dominance factor amongst spiders is size, which is not surprising as it is the same in many other species of animals.

Coming back to the question of why large spiders do not take advantage of this and take over the webs of other spiders. One possible explanation is that there are not enough webs of the right sort in any one area to encourage spiders to confront each other.

The next experiments found out whether *E. pustulosa* spiders could take over a cobweb. An *E. pustulosa* spider was put onto the web of *A. veruculata*, a common member of the family Theridiidae. Another member of the Theridiidae, *Steatoda grossa* (a relation to the katipo with a nasty bite) was also tested. In all cases the results were the same. Although the cobwebs were vacant none of the spiders (six repeats) stayed. They all behaved in a similar way, pausing first to find out if there was any other spider on the web, then walking in as close to a straight line as possible until they came to the edge (sometimes they headed towards the nearer side, and sometimes towards the opposite side of the web). They all left the cobweb and built their own orb-web else where.

In the next experiment the spider who owned the cobweb was left on it. When the invading spider was larger than the resident it ignored the owner completely, and behaved in the same way as above. The resident did not try to interfere with her. When the introduced spider was the smaller of the two, it was chased off by the owner of the web. The resident advanced rapidly, opening her palps. The invading spider backed off as fast as possible. The owner of the web behaved in exactly the same way when another spider of the same species was introduced.

When the two spiders were the same size the owner of the web came out of its retreat, and looked threatening. The invader also bared its fangs, but retreated off the web. The owner then went back into its retreat. Again, this was the same as what happened between two *A. veruculata* spiders.

From this we can see that *E. pustulosa* spiders cannot (or will not) take over the web of *A. veruculata*. Therefore it would probably be no particular advantage for spiders to take over each others' webs regularly, as the chances of finding an empty one belonging to another member of the same family are quite remote. However, if a species of spider evolved which could take over either (unlike *E. pustulosa)*, it can still be an advantage.

In the next experiments the spiders' memories were tested. Two spiders *(E. pustulosa)* were swapped between webs while one had just caught a small fly, and the other had nothing on its web. Both spiders paused for just over thirty seconds as they arrived, to find out if there was a spider on the web already. When they sensed that there was not, they went straight to the hubs (where the spider had brought the fly). Both checked all the other radii for signs of another spider, before the one with the fly settled down to eat it as normal. The other moved about a bit longer, checking one radius again (that was the one leading to the place where the insect had been caught on her own web). The results were the same in all six repeats. They were also the same when the experiment was using *E. pustulosa* and *C. viriditas* spiders. It was tried when both the *E. pustulosa* spiders started with the fly, and with the *C. viridatas* spider catching it. The results were still the same.

This shows that *E. pustulosa* spiders have some sort of memory. The spiders seemed to remember that they had caught something, and where on the web the insect had been caught.

The next experiment is related to web building and web swapping. Two *E. pustulosa* spiders were swapped onto each others' webs while they were in the middle of building. They were both up to the same point. Each time they were swapped they behaved in the same manner. They all went to the hub (or as much of it as existed at the time), and paused for about twenty seconds. Then they all finished the web in the normal manner.

The last experiment was the same, except the spiders were swapped when they were up to different points in building. For example, in one swap, one was up to laying the catching spiral when the other was only half way through laying the radii. The results were the same in all six swaps. They all went to the hub and paused, although usually for slightly longer than in the previous experiment. Then they all finished building in the normal way. This seemed at first to contradict my earlier hypothesis about the memory of the spiders. Then I realised that even if

they did know it was a different web they would continue, and they could not build from where they were up to, as all parts of an orb-web are supported by the rest.

CONCLUSIONS

In the first section of this project I found that spiders will only build their webs in dim light (between two and five electron Volts). This is probably because with less light they cannot see. If there is more light it is dangerous to move in case of attracting predators. This is the same light intensity as early evening or morning, when they normally build their webs.

They will not build if the direction of "down" is changed continually. If it is only changed a few times they will build, but their webs will not be normal. Slow, movement on a horizontal plane however does not affect them at all, even if it continues all night. This is probably because they can fall into the rhythm with the movement and become accustomed to it. Vertical rotation, however, confuses them because it disturbs their sense of gravity. Their webs are abnormal because they use gravity to help form the radial threads.

Spiders which are regenerating their forelegs will build webs with tighter coils and more radii. If they are regenerating any of their other legs it makes no difference to their webs. The differences in the webs are due to the fact that the spiders measure parts of their webs with their forelegs. Therefore if a foreleg is shorter than normal, parts of the web will be too.

The second section showed us how spiders can take over each others' webs. I found that they could take over the webs of other spiders of the same species, and different species within the same family. They could not take over the webs of spiders belonging to a different family, even if they had prey. If two *E. pustulosa* spiders are swapped while one had prey and the other did not the one that did not behaved normally. The one that had lost its prey seemed to remember slightly that it had it, but did not do anything about it.

If two *E. pustulosa* spiders were swapped while they were in the middle of building a web they would continue, from where the web was up to. This was probably because it is very difficult for a spider to build the catching spiral before the radii are finished, for example.

If a spider is put onto the web of another spider when it is there, the larger spider is clearly dominant, regardless of species. This is probably because spiders are cannibals.

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CONSERVATION RESEARCH ON NEW ZEALAND TERRESTRIAL ARTHROPODS: WHAT IS MOST IMPORTANT?

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INTRODUCTION

It is relatively easy to think of research projects but much more difficult to answer the question, how to most efficiently go about research with the limited resources available to conservation today.

I believe this to be the most important problem facing conservation research and particularly research concerning New Zealand's native terrestrial arthropods, especially since public and political awareness in this area is in its infancy. In this paper I identify those categories of species needing research and outline a procedure for deciding on an important conservation research topic. I will also identify the research resources New Zealand has and discuss a possible allocation of responsibilites.

Two things should be defined. By "conservation research" I refer to research which aims to yield knowledge which will directly benefit securing the survival of a species. Examples include habitat requirements and taxonomy. When speaking of " endangered species" I refer to the International Union for the Conservation of Nature's (IUCN) Survival Service Commission definition: "taxa whose population(s) is unlikely to survive unless conservation measures are taken." Finally, "arthropods" will refer to New Zealand indigenous terrestrial arthropods.

The demise of native species and the causes have been well described in literature. Arthropod species have declined due to habitat loss and/or modification and introduced mammals. I suggest that large-bodied arthropods are most susceptible to predation from introduced mammalian predators. They are also prone to habitat modification and/or loss because many have low productivity, poor

dispersal abilities (e.g., flightlessness) and may have comparatively long life cycles. The result of these characteristics is a poor ability to recover numbers from predation and/or habitat change.

Another group of arthropods which may also be at risk are those with specialised habitat requirements. While it is true that remnant populations can persist in very small areas, many habitat-types have been lost in New Zealand, along with their original communities of arthropods. Thus in selecting topics for research on arthropods, clues of importance are gigantism and/or restricted habitat use.

QUESTIONS THAT SHOULD BE ADDRESSED WHEN DECIDING UPON A TOPIC FOR CONSERVATION RESEARCH

(1) Are species endangered *sensu* IUCN

(2) Is their habitat threatened?

(3) What susceptibility is there to introduced predators?

(4) Is the species endemic to New Zealand and at what level?

(5) Does the species display different genetic characteristics from "conspecifics" elsewhere?

(6) Is/are the distribution and status of populations of the species sufficiently well known?

(7) Is/are the species protected by legislation?

(8) Is the species' habitat protected by legislation?

(9) Is the topic practically feasable?

A final decision to undertake research would, I believe, require an affirmative answer to all of these to win significant institutional investment of professionals and dollars.

The importance of good distributional data is obvious. If a species turns out to be abundant, then there is far less urgency for research. The opposite can also

apply. It is a matter for careful judgment to know when there has been enough survey work completed and it is time to invest further with full-blown research.

Practical solutions may not require scientific research. For some of our native species the threat is obvious and so is the solution, e.g., not converting a swamp to pasture. I think it is important to use common sense *a priori* to filter out those topics that really do require scientific input so that the best use can be made of research resources.

Having a species formally protected by legislation does not necessarily imply any intrinsic higher value over others. Rather, legislation is important because it formally or legally commits the government to protect the species and, hopefully, ultimately fund research. The legislative protection should provide a basis for setting priorities.

Having decided on a species for research I believe there is an ideal system to which conservation science should adhere which should contain these components in roughly this order:

Task No.1:
If not already done, a taxonomic description of the species or species group.

Research component :- Formal taxonomic description may take too long, especially if there is a group of species in question. The problem of so many species requiring description actually confounding conservation efforts has been described as the "taxonomic impediment" (e.g Ramsay *et al.* 1988). Modern genetic methods (e.g. gel-electrophoresis) offer a quicker alternative which will tell managers whether the species is unique or not.

Task No.2:
Establish the conservation status of the species at risk.

Research component:- Design any specialised survey methods. After standard techniques have been designed, evaluated and modifiifed as required, train management staff or undertake survey.

Task No.3:
Write a research plan which should be integrated with an interim species management or recovery plan.

Research component:- Proper scientific design and co-ordination with management staff. A pilot study may be necessary which will include an evaluation of methods.

Task No.4:
Conduct research, write it up and make recommendations.
This task may involve writing part of the recovery/management plan which would require close co-ordination with the agency responsible (e.g. Department of Conservation - DOC). The ideal is to conduct research in tandem with management practice, e.g. testing the significance of predation on target species during the normal course of predator control. (termed "wildlife management as scientific experimentation", McNab 1983.) Part of the recovery/management plan should include designing follow-up research, e.g. monitoring and implementing future management.

Task No.5:
Public and professional education, dissemination of information.

Research component:- Researchers owe it to themselves to invest time in educating the public and contractors in the results of their research. This will involve "popularising" results which requires special skills if accuracy is to be retained. Professional managers today often do not want to wade through scientific prose. The species recovery/management plan should ideally contain scientific results in lay terms by reference to refereed scientific papers. While supplying information to the media may not appear to have immediate benefits, it does long-term because ultimately, unless the public (and hence financial sources) perceive invertebrates as "valuable", then their conservation is jeopardised.

Task No.6:
Fund-raising

Research component:- Investigate potential financial backers - private and institutional. Some research organisations employ professional people full-time, to do this job. The task ties in with publicity since the trade-off for financial backing is often publicity. Other benefits may include scientific trials of new products. While there is a stated order in these tasks, in practice some will be carried out concurrently.

WHAT RESOURCES DOES NEW ZEALAND HAVE WHICH ARE PRESENTLY OR POTENTIALLY AVAILABLE FOR ARTHROPOD CONSERVATION RESEARCH?

Research institutions

All institutions could play a part in the aforesaid research plan.

Universities - staff and graduate research.

Philosophically there is no reason why management and theoretical research cannot be performed hand-in-hand.

Entomology Division (DSIR)

The Entomology Division have been traditionally responsible for taxonomy (e.g. Systematics Section). Hence in at least assessing species rarity, their work (e.g. Fauna of New Zealand) will be invaluable for conservation research.

Ecology Division (DSIR)

Presently the DOC contributes money towards conservation research through loop-funding - a system (current until July 1990) whereby research carried out by Ecology Division that is useful for conservation is funded by the DOC. Of course, Ecology Division supplies its own funds as well towards arthropod research. Ecology Division research on arthropods has mainly centred on ecological research aimed at conserving species.

Entomological Society (ENTSOC)

The society could (and has) provided a forum for debate on conservation issues. It has, and should in future, act as the most important visible advocate for arthropod research in New Zealand by prodding the DOC and other institutions. But this should be done in a co-operative manner. The society also has a wealth of information available with its membership and library. Many ENTSOC members are amateurs who can make an invaluable contribution to conservation research e.g. distributional data and hence conservation status.

Science and Research (S&R) Division, DOC

The Division is concerned with undertaking or facilitating research for its priorities list for arthropods which was published in September 1989 (Sherley 1989). It organised the publication of the last Wildlife Research Liaison Group Research Review No.10 (Ramsay *et al.* 1988) which summarises research and also identifies important research topics.

National Museum

The National Museum has a valuable record of arthropod distribution which could play an important role in conservation as a database.

Finally, New Zealand research institutes can take advantage of being in a small country by more efficiently co-operating in research. In a climate where funds are short, duplication cannot be afforded even if it involves simply sharing transport. Co-operation has been, and should be, facilitated through the ENTSOC.

DISCUSSION

What can ENTSOC and the above mentioned organisations do from here on?

1. Continue a "watching brief" on important conservation topics. If a research topic arises which implicates the DOC, then the Science and Research Division at least should be notified.

2. Advocate investment (people and money) in research topics which have been identified in current publications and new topics as they come to hand.

3. University researchers design research topics which involve conservation science and use these as a basis for grant-in-aid applications. Research design should involve a team approach involving government research institutions and include graduate students.

4. Ecology Division (DSIR) should continue to lobby for loop-funding from the DOC for mutually agreed priority research topics.

5. Science and Research (DOC) should continue to give some priority budget for research into native terrestrial arthropods given that there are about 20,000 species of insects and about 90% of these are endemic (Longworth in Mound and Walker 1982).

6. Entomology Division (DSIR) should recommend to conservation agencies at the earliest opportunity (even before formal publication) the identification of taxonomic rarities which may require urgent protection.

7. Using published research priorities, all institutions will have the opportunity to initiate research.

I believe co-operative research is the most important strategy to opt for when funding is so low. Certainly there have been outstanding examples of co-operative research in conservation research in vertebrates, it should be so for invertebrates as well.

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WETA NEMESIS
A note

A rare specimen of the orchid *Vanda coerulea*, from the Western Himalayas, cultivated in my garden at St Heliers, Auckland, suffered the loss of many of its new-forming root tips, only the upper ones however, and probably as a consequence, did not flower so well. The plant, grown in a basket placed in the fork of a sheltering cabbage tree *(Cordyline australis)*, is dormont during the dry (Auckland summer!) season and grows during the monsoon (Auckland autumn). Many new aerial roots are produced at this time, and it was the tips of these that were being eaten. The culprits were thought to be slugs or snails so the pesticide methiocarb, in the form of Mesurol in blue pellets, was spread around the plant. This was during the winter of 1988. Within a few weeks a large adult female weta, *Hemideina thoracica* (White), was found dead on the ground near the cabbage tree, soon followed by a total of ten more adult female *Hemideina* wetas all found dead

in the same general area. The eating of the orchid root-tips ceased. The following March (1989) one large dead male *Hemideina* was found dead in the same place together with two more males inside my house. By April 1989 the orchid was producing a profuse spike of manificent blue flowers, no doubt due to perhaps to a particularly favourable season as far as the climate was concerned, perhaps to improved husbandry, and perhaps also to the fact that wetas were no longer browsing its upper aerial roots.

It seems therefore that in this case, wetas, and not slugs or snails, were eating the *Vanda* orchid's aerial roots and that the slug bait, Mesurol, must have been eaten by the wetas which were thus poisoned.

There is another example of wetas causing damage to cultivated plants. In the Horotane Valley, near Christchurch, burrowing ground wetas, *Hemiandrus* sp., emerged at night and damaged a commercial apricot crop being grown there (Wahid 1978, Wahid & Scott 1979). It seems possible that wetas may have more effect on plants than is generally realised, especially as they are nocturnal, so that the results of their activity may not be recognised and are therefore attributed to other causes.

What a pity that the whole harem and its master, living in a secluded seraglio of massed dead cabbage tree leaves, had to die in order that a rare exotic intruder could flourish and produce its magnificent blue flowers!

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Mrs S. Bedford,
229 St Heliers Bay Rd,
Auckland

*

21st ANNIVERSARY RESEARCH GRANTS

1989 Grants:
Auckland Branch. $800 to construct a wetland waterway at Te Henga Swamp.

Mr R. Death, Canterbury University. $400 for investigating the effects of disturbances on stream insect communities.

Mrs O.R. Green, Auckland. $700 as part cost of a Wild M3Z drawing tube.

Dr A.C. Eyles, Levin. $200 for costs involved in a taxonomic study of the genus *Rhypodes* (Heteroptera) endemic to New Zealand.

Mr C. Jowett, Auckland University. $500 for a predation study of the Mahoenui Giant Weta (*Deinacrida sp.*).

Mr C.D. Millar, Auckland University. $300 for continuation of a study of melanism in New Zealand moths.

Ms W.L. Chadderton, Canterbury University. $300 toward costs for a freshwater study of parts of Southland for comparison with the freshwater invertebrate fauna of Stewart Island.

RESEARCH REPORTS RECEIVED DURING 1988-1989

Mr C.D. Millar (1987 Grant)
Mass rearing techniques for *Heliothus amigera* and *Mythima separata* have been established and a detailed study of *Mythimna* under laboratory conditions has been undertaken to provide a base line. These two species are reared on artificial diets contaminated with chemicals known to be associated with industrial pollution. A major setback occurred in this work owing to destruction of the colonies during spraying for cockroaches in the University buildings.

Dr V.B.Meyer-Rochow (1988 Grant)
40 glowworms have been observed to determine how they select small insects tangled in their threads. Vibrations are necessary before the glowworm investigates, but olfaction is also necessary - before the glowworm bites it checks to see if the object snared is edible. Observations are to be published in the Journal of Insect Behaviour.

Ms W. Pond (1988 Grant)
Newspapers in Education (Wellington) have prepared the poster "The Polynesian World of Insects" for publication at the end of the year. The Maori editor of the

Department of Education has proposed that a series of posters be done, not just this one, but this depends on the future of educational publishing and the new science curriculum.

Dr A.C. Clark (1988 Grant)
Work is progressing in developing localisation methods in polyacrylamide gels for the glutathione - S - transferases. Because of multiplicity of isoforms of these enzymes problems are encountered with overlapping enzyme bands. A higher resolution technique such as isoelectrofocusing will be tested to try and overcome this.

Mr M.Overton (1988 Grant)
Both red and yellow admiral are breeding well in continuous culture in the laboratory. Some hybrid forms can be obtained, indicating that the 2 are very closely related, and field - caught individuals may not be from pure populations. Artificial media have been tried, so far unsucessfully, and disease (mainly the nuclear polyhedrosis virus) has also been a problem. Larval food preferences are wider than previously thought - both species developing completely on all of the 3 different nettle species tested.

*

MID-WINTER EMERGENCE OF A *PROCORDULIA GRAYI* IMAGO (ODONATA: CORDULLIDAE).

A. C. Harris, Otago Museum,
Great King Street, Dunedin, New Zealand.

In early April, 1989, Mr. R. R. Baldwin (Zoology Department, Otago University) dredged a final instar larva *Procordulia gravi* (Selys) from the bottom of a pond situated beside Woodland Avenue, Mosgiel, Dunedin. The pond is about 40 metres in diamneter, almost round, and is entered and drained by a permanent seepage or small creek. The larva was found at a depth of about 1.5 metres, adhering to the lower part of a clump of Elodea (*Anacharis canadensis*). The larva was transferred to a 22 x 18 x 15 cm plastic tank containing shingle, stones and water 1.5 cm deep. It was kept in an unheated building at room temperature.

On 28 July 1989 a perfect adult female *P.gravi* emerged and climbed up the walls of the container. Mr Baldwin removed the imago and its exuvia and gave them to me. These are currently housed in the collections of the Otago Museum.

REMARKS

Adult dragonflies in their natural environments usually emerge from their penultimate instars in spring or summer (never winter). In the tropics, emergence is generally a function of temperature alone, whereas in temperate regions, it is usually controlled by additional factors such as photoperiod and a facultative dispause in the final larval instar which synchronises emergence of the adults (Corbet 1983).

Adult emergence in *Procordulia gravi* normally occurs between mid-November and February, with most individuals emerging by mid December (Rowe, 1987). Rowe (1987) noted that at Lake Alexandria emergence can be delayed up to a month when spring is late. Little is known about the duration of larval life, but Rowe (op. cit.) suggested that it would probably be at least two years.

It would seem likely that the larva under normal circumstances would have overwintered, perhaps in a facultative dispause, until the pond water rose to the temperature necessary for emergence of the imago in November, 1989. Rowe (op. cit.) has indicated clearly that ambient temperature is of major importance for emergence in this species. It would therefore appear that the constant warm temperature in the building either broke the dispause or prevented its onset and caused the larva to metamorphose into an imago when the water attained a critical temperature.

ACKNOWLEDGEMENT

I am very grateful to Mr. R. R. Baldwin for the specicmens and information.

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OTAGO SECTION

Rubbish Dump Report.

Progress has started on talks about the new Cromwell tip, between the Conservation Department and the Cromwell Borough Council as D.O.C. awaits a reply to their proposal. Meanwhile the signs should be up around the reserve and an allocation of money should see the rabbit fence completed this season and allow serious control measures to be taken. The beetles will be emerging soon however, and this will delay the work, probably until summer.

Kees Green and Brian Patrick have been in the newspaper recently about some work they are doing with a rarely found Noctuid moth. The Spring Dune Moth, (*Agrotis innominata*) has been found living in sand dunes at St. Clair, St. Kilda, and Smaill's beaches. Usually for a noctuid the female is brachypterous (short winged and unable to fly). This means they are stranded there and have to feed on introduced plants (Marram grass) as the natives are now completely lacking there. Another odd feature of its life cycle is that the adults emerge in winter on suitable nights, as well as spring.

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THE GOLDEN ORBWEAVER, A SPIDER CREATING INTEREST IN NEW ZEALAND.

C J Green, Dept. of Conservation
Private Bag 8
Newton, Auckland

In the past, a species of golden orbweaving spider (*Nephila sp.*) has appeared in various places in New Zealand. In 1975 one was collected in Dargaville, then another in 1976 in Tauranga. Then in the autumn of 1982 one turned up in Cambridge, near Hamilton.

More recently in April 1988, a single specimen was found in a suburb of Hamilton, and in the same month one spider in a suburb of Auckland. Given the previous history, these two records didn't seem unusual. However, in February 1989 this species of spider began to appear in an increasing number of localities throughout the wider Auckland metropolitan area. In addition, reports came in from many

other cities, spreading virtually the length of the North Island, from Whangarei in the north to Martinborough in the south.

By the end of May 1989, 28 golden orbweavers had been recorded over the last summer season in the North Island. There have been no new records in June or July. Over the same period there were no records from the South Island.

With the infrequency of the *Nephila* genus appearing in New Zealand it has been assumed that all these records over the past two seasons are the same species. They appear to be either *N. edulis* or a very closely related species. Only females have been found, usually by members of the public quite unused to such large spiders. It is by far the largest species of orbweaver found in New Zealand.

Much speculation has surrounded the likely mode of transit of the species to New Zealand. It was assumed the most likely source would have been somewhere in Australia, since *N. edulis* can apparently be quite common on eastern coastal areas. It is possible that immature spiders were blown across the Tasman Sea and landed in New Zealand. However, the pattern of distribution does not match that seen in other Australian immigrants arriving in New Zealand. In particular, many lepidoptera have been recorded as arriving in coastal parts of New Zealand, particularly Taranaki, West Auckland, Firth of Thames, Wellington-Horowhenua and Nelson.

It seems more likely to some of us that a mature female or a viable egg sac travelled across the Tasman courtesy of modern day transport. It has not gone unnoticed, that most of the records over the last season occurred in cities on the main trunk railway line.

Speculation also surrounds its possible future in New Zealand. Will it be able to survive our winters and thrive? Several spiders have been under observation by entomologists in Auckland and Wellington, both indoors and outdoors. Indications are that the adult females do not survive past June having laid egg sacs in April. A number of egg sacs will receive close observation in the spring. These eggs could be fertile if mating had occurred prior to capture. We await any new arrivals in the spring with trepidation.

New Zealand Butterfly Poster

Printed in colour fast colours on medium card. This poster comes in a folded/creased version or as an uncreased poster.

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NEWS FROM AUSTRALIA

Next year's annual conference of the Australian Entomological Society has been set for mid-winter (30 June - 4 July) in chilly Canberra. Canberra has a large population of local entomologists in CSIRO and this, coupled with Canberra's central geographic position, always guarantees a big roll up. Themes of symposia and sessions already being organised include insect/plant interactions, molecular biology, evolutionary ecology, applied taxonomy, post harvest entomology, *Heliothis* biology and aquatic entomology. The conference log features the Bogong moth, *Agrotis infusa*, a migratory noctuid which periodically invades Canberra in great numbers, It is particularly appropriate because it has made the news lately by almost shutting down our new bicentennial Parliament house due to tonnes of moths coming to the brilliant outside illumination lights. Conference details are available from Dr Joanne Daly, CSIRO Entomology, GPO Box 1700, Canberra ACT 2601.

On the topic of the power sometimes wielded by our tiny lepidopteran friends, it is nice to be able to relate that another real estate development has been prevented by a rare butterfly. Last year we had massive public protest because a housing subdivision near Melbourne threatened the habitat of the Eltham Copper, *Paralucia pyrodiscus lucida*. Finally the critical area was excised from the subdivision. This

year we have seen a large marina development in Brisbane's Moreton Bay stopped in its tracks because of potential destruction of the habitat of the rare mangrove

butterfly, *Acrodipsas illidgei*. This butterfly has recently been proved to feed on ant larvae in its larval stage, a habit long suspected but just demonstrated on film by Peter Samson.

The *Australian Entomological Magazine* is a quarterly periodical devoted to shorter and lighter articles on insects of the Australasian region. It was founded in 1972 by well known Sydney private entomologist, Max Moulds, and was operated for 15 years by him as a private enterprise. Last year he transferred its operation to the control of the Entomological Society of Queensland. That Society would welcome subscribers (Aust. $16.00 PA) or contributors from New Zealand. Enquiries should be sent to the Business Manager, Australian Entomological Magazine, Entomology Department, University of Queensland, St. Lucia, Qld 4067.

Geoff Monteith
Australian Correspondent.

INDEX TO THE WETA

This index was compiled by Peter Maddison, DSIR, Auckland.

Please excuse the small type: Unfortunately, perestroika (or is is glasnost) does not occur between DSIR and MAF - our computers are quite incompatible and I didn't really want to retype 75 pages. This meant I was unable to adjust the size without going to one column per page. Putting the index into one column would have meant printing a very fat Weta and with it, incurring considerable extra cost.

I have probably got the worst eyesight of anyone in the society and I can read it - this was the criteria I worked on and I also like to save money!

So, my apologies to Peter, for reducing him so much.

Happy Christmas and New year and keep that copy rolling in.

Thanks,

John Tenquist

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Prepared by P.A. Maddison

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